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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Avto Tavkheldze

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EXAMINER

GARDNER, SHANNON M

ART UNIT

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/531,367	Applicant(s) TAVKHELIDZE ET AL.	
	Examiner SHANNON GARDNER	Art Unit 4132	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 13 April 2005 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date <u>12/31/2007 and 4/13/2005</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Priority

1. Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119(a)-(d). The certified copy has been filed in parent Application No. PCT/IB03/06480, filed on 10/20/2003.

Claim Objections

1. Claim 16 is objected to because of the following informalities: claim 16 requires "the depth of indents in said indented cross-section or the height of protrusions in said protruded cross-section is in the range 10-100 λ "; this is not supported by Applicant's specification. Applicant discloses the depth of the indents or the height of protrusions to be comparable to the de Broglie wavelength, not in the range of 10-100 λ (see pp 2 of Specification). Examiner suggests changing claim 16 to read "the width of indents...or width of protrusions", as supported by the specification, and the claim will be treated as such for the purposes of this action. Appropriate correction is required.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. The term "much more" in claim 5 is a relative term which renders the claim indefinite. The term "much more" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1-2, 6-12, 14, 16, 18, and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Ghoshal (WO 02/47178, cited in IDS).

As to claim 1, Ghoshal is directed to a tunnel barrier for controlling the movement of electrons through a thermoelectrical material comprising a potential barrier having an indented or protruded cross-section (see Figure 14; pp 16, 3rd and 4th paragraphs; also see Figure 2; pp 9, 1st and 2nd paragraphs).

Regarding claim 2, the reference teaches the depth of indents in said indented cross-section or the height of protrusions in said protruded cross-section to be chosen to set a threshold energy value above which the barrier is transparent to electron flow, and below which electron flow is prevented (pp 9, 2nd paragraph; see also Figure 14 and pp 16, 3rd and 4th paragraphs).

Regarding claim 6, the reference teaches the potential barrier comprising an electrical insulator, Ghoshal teaches evacuating the areas between and around the tips (250) this evacuation reads on the instant electrical insulator (pp 6, 4th paragraph to pp 7, 2nd paragraph and pp 8, 2nd paragraph).

Regarding claim 7, Ghoshal is directed to a thermoelectric device (Figure 2) comprising a first thermoelectric material (210), a second thermoelectric material (212), and one or more tunnel barriers of claim 1 (216, also see Figure 14 (1402)).

The reference teaches the use of tips 1402 (Figure 14) being usable in a thermoelectric cooler to provide tunneling of electrons (see pp 16, 4th paragraph). The use of these tips (1402) in the thermoelectric cooler (Figure 2) taught by Ghoshal is clearly within purview of the reference.

Regarding claims 8-10, the reference teaches the first thermoelectric material (210) comprising an n-type material, the second thermoelectric material (212) comprising a p-type material, and a tunnel barrier (250) in electrical contact with an anode of the n-type material and a cathode of the p-type material.

It is the Examiner's position that the tunnel barriers (250), the thermoelectric materials (210 and 212), and the electrodes taught by Ghoshal are all in electrical contact. Therefore claims 8-10 are met.

Regarding claim 11, the reference teaches a method for making the thermoelectric device comprising forming an indented or protruded structure on a surface of a first thermoelectric material, forming an electrically insulating material over the indented or protruded surface, and attaching a second thermoelectric material to the insulating material (pp 8, 2nd paragraph; Figure 8; pp 12, 4th paragraph - pp 13, 2nd paragraph).

It is the Examiner's position that Ghoshal's evacuation of the areas between the around the tips (250) reads on the instant forming of an electrically insulating material

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over the indented or protruded surface as the vacuum is formed when the area is evacuated.

Regarding claim 12, the reference teaches the step of forming an insulating material comprising depositing the insulating material (Figure 8; pp 12, 4th paragraph - pp 13, 2nd paragraph).

It is the Examiner's position that the instant step of depositing the insulating material is met by Ghoshal's teaching of forming an evacuated seal in the areas between and around the tips of his device.

Regarding claim 14, the reference teaches the step of forming an indented or protruded structure comprising etching (Figure 8; pp 12, 4th paragraph - pp 13, 2nd paragraph).

Regarding claim 16, the reference teaches the width of indents or width or protrusions in the tunnel barrier being in the range of $10-100\lambda$, where λ is the de Broglie wavelength of the electrons (Figure 5; pp 11, 2nd paragraph).

At 300K, an average electron has a de Broglie wavelength of approximately 9nm. Therefore the instant range of $10-100\lambda$ would be approximately 90-900nm. The tip radius of the tunnel barrier (which reads on the instant width of protrusion) taught by Ghoshal ranges from 30-50nm. This radius clearly falls within the range required in the instant claim, thus claim 16 is met.

Regarding claims 18 and 20, the reference teaches the first or second thermoelectric material being selected from the group consisting of: Bi_2Te_3 , Sb-doped Bi_2Te_3 , Se-doped Bi_2Te_3 , $\text{Bi}_{1-x}\text{Sb}_x$, and CoSb (see claims 5 and 6).

6. Claims 1-5 are rejected under 35 U.S.C. 102(b) as being anticipated by Tavkhelidze (US 6281514, cited in IDS).

As to claim 1, Tavkhelidze is directed to a tunnel barrier (Figure 2, (17)) comprising a potential barrier having an indented or protruded cross-section (also see column 4, lines 50-60).

Claim 1 recites the tunnel barrier being "for controlling the movement of electrons through a thermoelectric material" which is directed to intended use and will therefore not be given undue weight. However, even if this were to be given weight in the claim, it is the Examiner's position that the thermionic materials utilized in '514 read on the instant thermoelectric materials and the movement of electrons through the tunnel barrier would certainly be controlled (see column 4, lines 60-67).

Regarding claim 2, the reference teaches the depth of indents in the indented cross-section or the height of the protrusions in the protrusion cross-section being chosen to set a threshold energy value above which the barrier is transparent to electron flow, and below which electron flow is prevented (column 4, line 55 to column 5, line 25).

Regarding claim 3, the reference teaches the depth of the indent in the indented cross-section being given by the relationship $(n\lambda + \lambda)/4$, where n is 0 or a positive integer (column 4, line 50 to column 5, line 10). It is the Examiner's position that for certain values of n (i.e. $n=0$), this relationship will give the same indent depth as required by the instant claim. Therefore, claim 3 is met.

Regarding claim 4, the reference teaches the integer n having a value between 0 and 4 (see claims 4 and 6-7).

Regarding claim 5, the reference teaches the width of indents in the indented cross-section or width of protrusions in the protruded cross-section is much more than λ , where λ is the de Broglie wavelength of the electrons, and where n is 0 or a positive integer (column 5, lines 1-25). It is the Examiner's position that the indent width being on the order of 2λ , as taught by '514 reads on the instant "much more than λ ". Therefore, claim 5 is met.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

9. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein

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were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claims 13, 17, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ghoshal as applied to claim 1 above, and further in view of Saida et al. (US 5866930).

Regarding claim 13, Ghoshal is silent as to the step of forming an insulating material comprising oxidizing the first material.

It is known in the thermoelectric art to oxidize a thermoelectric material to form an insulating layer, as taught by Saida et al. (Figure 5A-5C; column 9, lines 9-37), to ensure structural stability of the thermoelectric device.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize thermal oxidization to form the insulation material, as taught by Saida et al. to ensure the structural stability of the device and to maintain the nanometeric distance between Ghoshal's tips (Figure 14 (1402)) and the lattice structure (1404) to allow for tunneling.

Regarding claims 17 and 19, Ghoshal is silent as to the electrical insulator being selected from the group consisting of: SiO_2 , Si_3N_4 , Al_2O_3 and titanium oxide.

However, it is well known in the thermoelectric art to utilize SiO₂ as an electrical insulator, as taught by Saidi et al. (Figure 5A (112); column 9, lines 9-37) as formation of SiO₂ is well known easily executed.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize SiO₂ as an electrical insulator, as taught by Saidi et al. (Figure 5A (112); column 9, lines 9-37) to allow for ease of insulator formation.

11. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ghoshal as applied to claim 11 above, and further in view of Brannon.

Regarding claim 15, Ghoshal is silent as to the formation of an indented or protruded structure comprising ablation.

However, it is known in the art that ablation and etching are substantially similar and essentially interchangeable (Brannon; pp 11, 2nd column to pp 12, 2nd column).

Therefore, the formation of an indented or protruded structure by either etching (Ghoshal, Figure 8) or ablation would produce a substantially similar result; the use of either would clearly be within the purview of one of ordinary skill in the art. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945).

Contact/Correspondence Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SHANNON GARDNER whose telephone number is

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(571)270-5270. The examiner can normally be reached on Monday to Thursday, 8am-5pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jessica Ward can be reached on 571.272.1223. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/S. G./
Examiner, Art Unit 4132

/Jessica L. Ward/
Supervisory Patent Examiner, Art Unit 4132